Coho Salmon *(Oncorhynchus kisutch)* Utilization of Tributary Lakes and Streams in the Keogh River Drainage, British Columbia

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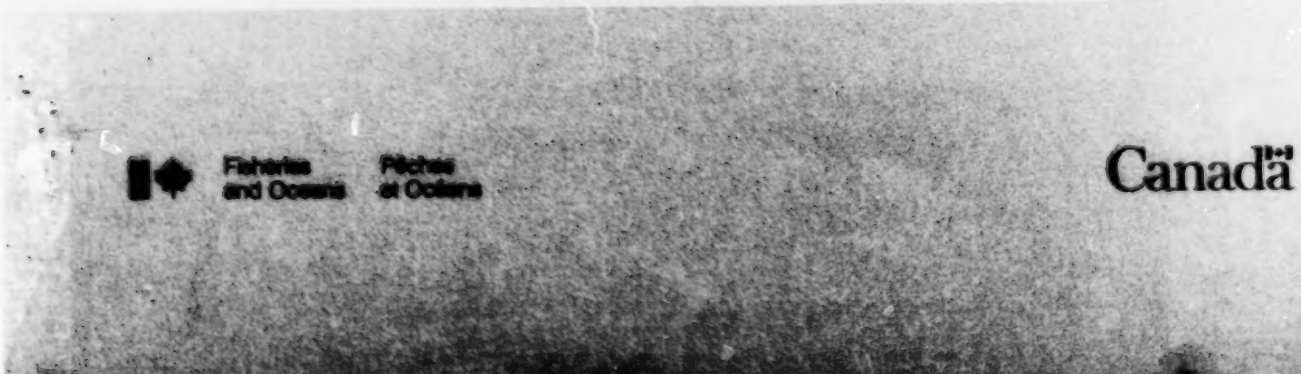

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COHO SALMON (*Oncorhynchus kisutch*) UTILIZATION OF TRIBUTARY LAKES AND STREAMS IN THE KEOGH RIVER DRAINAGE, BRITISH COLUMBIA

by

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ABSTRACT

Johnston, N. T., J. R. Irvine, and C. J. Perrin. 1987. Coho salmon (Oncorhynchus kisutch) utilization of tributary lakes and streams in the Keogh River drainage, British Columbia. Can. MS Rep. Fish. Aquat. Sci. 1973: 54 p.

Salmonid utilization of tributary lakes and streams in the Misty Lake and Long Lake sub-drainages of the Keogh River, British Columbia was studied between November 1985 and April 1987. About 30-45 adult coho spawned below Misty Lake, but adult fish were not found above the lake. Juvenile rainbow trout migrated up Misty Outlet stream in November after the first freshet, but juvenile coho did not show directional movement in the fall. Neither adults nor juveniles moved upstream in Misty Inlet stream. Coho fry migrated upstream towards Misty Lake and Long Lake soon after emergence, and reared in the lakes and tributary streams throughout the summer and winter. Smolts migrated downstream in mid-May at a size of about 95-100 mm fork length. We believe that small tributaries and lakes are important rearing habitats for juvenile coho and overwintering habitats for rainbow trout.

RESUME

Johnston, N. T., J. R. Irvine, and C. J. Perrin. 1987. Coho salmon (Oncorhynchus kisutch) utilization of tributary lakes and streams in the Keogh River drainage, British Columbia. Can. MS Rep. Fish. Aquat. Sci. 1973: 54 p.

Entre novembre 1985 et avril 1987 nous avons etudié l'utilisation des petits lacs et ruisseaux affluents dans les sous-bassins de Lac Misty et Lac Long dans le bassin hydrographique de la rivière Keogh, Colombie-Britannique par des salmonoides. Environ 30-45 adultes de saumon coho ont frayé en aval du Lac Misty, mais les adultes n'étaient pas trouvés en amont du lac. Les truites arc-en-ciel juvéniles ont immigré dans le ruisseau d'issue Misty en novembre après la première crue automnale, mais les saumons coho juvéniles n'ont pas fait des mouvements directionnels. Ni les adultes ni les juvéniles ont immigré dans le ruisseau d'arrivé Misty. Les jeunes tacons de saumon coho ont immigré vers les lacs Misty et Long peu après leur naissance. Ils ont habité les lacs et les ruisseaux affluents pendant l'été et l'hiver. Les smolts ont émigré en mi-mai à une longueur d'environ 95-100 mm. Nous croyons que les petits lacs et ruisseaux affluents soient des habitats très importants pour l'élevage des saumons coho juvéniles et qu'ils soient les habitats d'hiver des truites arc-en-ciel juvéniles.

INTRODUCTION

Small tributary streams and lakes may be important habitats for the production of juvenile coho. Autumnal migrations of juvenile coho into smaller tributary streams and small lakes are well-documented (Skeesick 1970; Bustard and Narver 1975; Peterson 1982; Tschaplinski and Hartman 1983) and are believed to be a mechanism to increase winter survival by avoiding unfavourable winter conditions in mainstem rearing habitats. Coho that overwinter in small ponds may show increased growth rates relative to fish in main channel habitats (Swales et al. 1986). Rainbow trout are also known to make similar autumnal migrations into smaller tributaries (Hartman and Brown 1987).

Juvenile coho are occasionally reported as being present in lakes during the summer (Gribanov 1948; Russell et al. 1981; Hyatt et al. 1984). However, there are few data on the spring and summer movements of juvenile coho into lake and pond habitats or their subsequent growth and survival in such areas.

The data presented in this report were collected to document the use of small tributaries and lakes by juvenile coho and other salmonids throughout the year. The data may lead to a greater recognition of the importance of small lakes and tributary streams to the production of coho salmon.

MATERIALS AND METHODS

STUDY SITE

The utilization of tributary streams and lakes by coho and other salmonids was examined in the Misty Lake and Long Lake drainages of the Keogh River, northern Vancouver Island (Fig. 1). The Keogh River (RAB No. 92-1000) is a small coastal stream which undergoes large flow variations during the winter rainy season. Descriptions of the river and its watershed are given in Ward and Slaney (1979) and Johnston et al. (1986).

The Misty Lake and Long Lake drainages are small tributaries which enter the Keogh River about 11 and 13 km upstream from the river mouth. The Misty Lake system comprises Misty Inlet stream, Misty Lake, and Misty Outlet stream while the Long Lake system comprises Long Lake and Long Outlet stream. The lakes are small and shallow, and the streams are small (Table 1).

Table 1. Physical characteristics of the study sites (after Swales et al. 1988).

Parameter	Misty Inlet	Misty Lake	Misty Outlet	Long Lake	Long Outlet
Length (km)	5.3	-	2.3	-	0.9
Mean width (m)	1-3	-	2-4	-	1-2
Mean flow ($cm \cdot s^{-1}$)	25	-	-	-	40
Mean depth (m)	0.5-1.0	2.0	0.5-1.0	2.5	0.3-1.0
Area (ha)	1.0	25.0	0.5	8.3	0.1
Shoreline (km)	-	2.8	-	1.8	-
Average gradient (%)	1.5		0.7	-	0.9

The fish fauna of the Keogh River drainage is described by Johnston et al. (1986) and Swales et al. (1988). Juvenile coho salmon and steelhead trout (Salmo gairdneri) are common and resident cutthroat trout (S. clarkii) and Dolly Varden charr (Salvelinus malma) also occur. Three-spined stickleback (Gasterosteus aculeatus) are found in the lakes.

SPAWNER SURVEYS

The numbers of adult coho that spawned in Misty Outlet stream downstream of the Rupert Main logging bridge (Fig. 1) in 1986 were estimated from visual counts obtained by periodic foot surveys of the stream. We did not find spawning habitat in the outlet stream above the bridge. The methods followed those of Johnston et al. (1987), and used either two or three observers working together and progressing downstream. Carcasses were measured, and slashed to prevent recounting. Spawning gravels in Misty Outlet stream occurred primarily as pool tail-outs whose areas were determined by measuring the stream width and the length of the gravel patch.

Regular spawner surveys were also conducted in Long Outlet upstream of the highway crossing. The downstream areas of Long Outlet are bogs which are unsuitable for spawning. Surveys were also occasionally done on the lowermost sections of Misty Inlet stream.

Coho escapements in Misty Outlet stream were estimated as peak live counts, peak live plus accumulated dead counts to that time, total dead counts, area-under-the-count curve, and the number of redds times two spawners per redd. The AUC estimates used a stream life of 11.4 d obtained from mark- recapture surveys for Keogh River coho (Johnston et al. 1986).

COUNTING FENCES

Adult counting fences were operated on Misty Outlet and Misty Inlet streams between 6 October 1986 and 30 January 1987. The Outlet stream fence was located at the site of a former B.C. Fisheries Branch fence (Fig. 1), about 1100 m above the confluence of the stream with the Keogh River (de Hrussoczy-Wirth 1979). The Inlet fence was located about 50 m below the highway crossing.

The Outlet fence consisted of 1.3 m X 1.3 m panels of heavy gauge 1 cm square wire mesh mounted on wooden frames (5 cm X 10 cm). The panels were spiked to a permanent sill consisting of a 20 cm X 20 cm timber anchored between rock-filled wooden bulkheads (1.3 m X 1.3 m X 1.3 m) at the stream margins. The fence was braced with triangular supports on the downstream side. The bottom of the fence was sandbagged to provide a slight head of water which discharged through the trapbox at low stream flows. A trapbox for upstream moving fish was installed next to one bulkhead. It was 1.25 m long by 1 m wide by 1.2 m high, and was constructed of 2 cm plywood with 1 cm square wire inserts (80 cm X 35 cm) on the sides to permit flow through the trapbox. The entrance cone was 35 cm X 55 cm. Trapboxes of this design are routinely used to catch coho broodstock in the Port Hardy area.

The Inlet fence was similar in design except that it was spiked to a temporary sill that was anchored by rebar driven into the streambed and by sandbags, rather than by bulkheads.

The fences were checked daily. All fish were enumerated and fork lengths measured. Water depth at the trapbox was measured with a staff gauge and water temperature recorded from maximum-minimum thermometers mounted at the trapbox. The fences were cleaned as required; during the freshets associated with rainstorms, the fences were cleaned several times daily.

Both fences were damaged at various times by debris transported during freshets. The Outlet trap did not operate for 3 days between 19 and 26 November. The Inlet trap was extensively damaged on 18 November and was not fully repaired until 9 December. These failures occurred about 1 month after adult coho had entered the Keogh River the previous year (Johnston et al. 1986), occurred after the death of most coho spawning in the lower portion of Misty Outlet, and so may not greatly alter our catch results.

FRY TRAPPING

The movements of small fish were monitored in Misty Inlet, Misty Outlet, and Long Outlet streams between 5 July and 13 August 1986, and between 6 October 1986 and 13 April 1987 using upstream-downstream fry traps (Northcote 1969) anchored to the stream bottom. The fry traps were placed about 25 m below the Inlet fence, 10 m below the Outlet fence, and about 200 m above the highway crossing respectively. The traps were in areas of moderate flow and were near the middle of the channels, at depths of 0.3-0.5 m. The traps were examined daily from October until late January and irregularly thereafter. All fish species in the upstream and downstream portions of the traps were enumerated and measured.

Smaller, fine mesh traps of the same design were operated in the spring along the stream margins at depths less than 0.3 m spring to catch migrating fry.

SMOLT TRAPPING

The emigration of coho smolts from Long Lake and from Misty Inlet stream was monitored between 25 March and 1 July 1986 by capturing the downstream migrating fish in smolt traps. The smolt traps were "Alaska-type" fyke nets of 1.9 mm nylon mesh which completely blocked the streams. The nets were placed about 50 m below the highway crossing on Misty Inlet and about 200 m below Long Lake on Long Outlet. The nets were usually fished for three consecutive nights per week. All fish species were enumerated and classified as parr or smolts on the basis of colouration. Wet weights were measured for the first 10 coho using an O'Hauss electronic balance and fork lengths were taken for the first 20 coho in each sample. Fork lengths were generally measured for all other species except stickleback. The total smolt output was estimated from the areas under the catch curves.

MINNOW TRAP SURVEYS

The relative abundance and size composition of the juvenile salmonid populations in Misty Inlet, Misty Lake, Long Lake, Long Outlet, and the Keogh River about 100 m upstream of the highway crossing (Fig. 1) were determined from minnow trapping conducted at 2-3 week intervals from November 1985 to April 1987. Minnow trapping was also done on Misty Outlet near the Rupert Main bridge from October 1986 to April 1987.

The minnow traps and trapping methods are described in detail in Swales et al. (1988). Fifteen to 20 traps were used at each site. The minnow traps are believed to be non-selective by size over the range from 50-130 mm (Bloom 1976), and are assumed to be equally effective in all the habitats studied. In the spring of 1987, some of the traps were lined with fine mesh hardware cloth to retain newly emerged fry which can escape through the wire mesh from which the traps were constructed. All fish species were enumerated and fork lengths measured to the nearest mm. Results are expressed as catches per trap-night.

In late January and early February 1987, mark-recapture censuses were conducted at each trapping site by capturing and marking fish over 10 consecutive days. Population sizes were estimated using the Schumacher modification of the Schnabel method (Ricker 1975) and by the Bayesian method (Gazey and Staley 1986).

RESULTS AND DISCUSSION

Adult coho were found in Misty Outlet stream from late October until 2 December 1986 (Table 2). The peak live count was 25 fish on 14 November, the peak live count plus accumulated dead was 31 fish, the total dead count was also 31 fish, and the AUC estimate was 48 fish using a stream life of 11.4 d. A total of 10 redds were found, which suggests about 20 spawners. The coho escapement into Misty Outlet therefore was about 30-45 spawners. The mean post orbital - hypural plate length of dead coho was 54 cm for adult males (SD=6, n=6), 53 cm for adult females (SD=8, n=5), and 32 (SD=2, n=2) for jacks. The values are similar to that (54 cm) reported for adult coho entering the Keogh River (Johnston et al. 1986).

A single adult coho was caught at the Misty Outlet counting fence. However, 6 coho carcasses were found above the fence, so that the fence count is clearly incomplete. The 6 dead coho found above the fence were all males, and included two jacks. Redds were not found above the counting fence in the limited areas of gravel, so that there is no clear evidence of spawning activity above the fence. Adult coho were not seen in Misty Inlet, nor in upper Long Outlet.

Spawning habitat in Misty Outlet stream was limited to pool tail-outs. Most of the redds that were found were located at pool tail-outs. The 12 pool tail-outs that we located had a total area of about 150 m^2 and thus comprised about 3.4% of the stream area below the fence. The estimated escapement is sufficient to fully utilize the available

spawning habitat.

Table 2. Visual counts of live coho, carcasses and redds obtained in foot surveys of Misty Outlet stream below the Rupert Main logging bridge.

Date	Live Coho	Carcasses	Redds
31 Oct 1986	9	1	-
04 Nov 1986	-	1	-
11 Nov 1986	-	2	3
14 Nov 1986	25	2	0
17 Nov 1986	5	5	2
02 Dec 1986	1	2	0
05 Dec 1986	1	8	5
12 Dec 1986	0	6	0
15 Dec 1986	0	4	0
TOTAL	-	31	10

The water depths and temperatures measured at the Misty Outlet counting fence showed marked changes in early November after the (abnormally late) start of the autumn rains (Fig. 2). Similar patterns of water depth and temperature were seen at all sites. The water depth fluctuated greatly in response to rainfall. Temperatures decreased from about 10° C to about 4° C after the start of the rainy season. Temperatures were 1-2 degrees colder at the Misty Inlet fence.

Daily catches at the Outlet and Inlet counting fences are given in Appendix 1 for the fall and winter period. A large number of juvenile rainbow trout (or steelhead) moved upstream past the Outlet fence in early November at the time of the first flow increase, but just prior to the decrease in water temperature (Fig. 3). As a corresponding pulse of rainbow trout was not observed at the Inlet fence, the trout evidently overwintered in Misty Lake or in the portion of Misty Outlet stream above the counting fence. The migration of rainbow trout out of mainstem habitats into small tributaries also occurs in Carnation Creek (Hartman and Brown 1987), and may allow the fish to avoid the large fluctuations in discharge seen in both the Keogh River and Carnation Creek during the winter.

The catches of other juvenile salmonids at the counting fence did not strongly suggest upstream migrations. About 55 juvenile coho were captured at the Outlet fence at the same time as the 400+ rainbow trout. Only five Dolly Varden were caught at the Outlet fence. The total catches at the Inlet fence were three coho and two Dolly Varden. Thus, if the coho taken at the Outlet fence do in fact represent an

autumn migration as commonly reported for coho, it would seem that the juvenile coho also overwintered in Misty Lake. It is possible that very small fish could pass through the wire mesh on the fence, but the accumulation of leaves and debris on the mesh would tend to prevent this occurrence.

The catches in the upstream-downstream fry traps at Misty Inlet, Misty Outlet, and Long Outlet streams are given in Appendix 2 and are summarized in Table 3. Fry movement was not recorded during the summer. The movement of juvenile coho was random at all sites, both in the fall and in the winter ($p>0.05$, G test or exact probability, Table 3). Rainbow trout moved upstream in Misty Inlet in the autumn (G test, $p<0.01$) but not elsewhere, which suggests the Keogh River as the likely source of the trout. Cutthroat trout also moved upstream in Misty Outlet in the fall ($p=0.035$), but the numbers caught were low, 7 moving up and 1 moving downstream.

Table 3. Catches of juvenile salmonids in upstream and downstream fry traps in the autumn (6 Oct - 31 Dec) and winter (01 Jan - 13 April) and probabilities of random movement calculated from binomial distributions.

Location	Period	Coho			Rainbow Trout		
		up	down	prob	up	down	prob
Misty Outlet	Autumn	14	13	>0.050	40	12	<0.010
	Winter	8	2	0.054	10	4	0.089
Misty Inlet	Autumn	0	2	0.250	0	0	
	Winter	1	2	0.500	3	1	0.313
Long Outlet	Autumn	4	1	0.188	0	2	0.250
	Winter	1	0	-	0	0	

The smaller fry traps, which were fished in the shallow stream margins in Misty Outlet and Inlet between 18 March and 13 April 1987, caught upstream migrating coho fry in Misty Outlet but not in Misty Inlet. The fry (mean fork length = 35 mm, SD=2, n=55) were moving upstream, as only 3 were caught in the downstream direction while 55 were caught in the upstream direction ($p<0.01$, G test). As only 3 fry were caught in the larger fry traps placed in the middle of the stream, it is clear that the fry movement occurred primarily along the shoreline, as has been reported for other salmonids (Northcote 1969). Daily catch records for the small fry traps are given in Appendix 3.

The downstream migrations of coho parr and smolts in both Misty Inlet and Long Outlet began in the last week of

April, peaked between May 7-16, and ended by the first week of June (Fig. 4). The smolt trap catches totalled 384 coho in Misty Inlet and 677 coho in Long Outlet, fishing 3 days per week. The estimated numbers of outmigrants are 1600 - 1700 from Long Lake and 700 - 760 from Misty Inlet. The catches in Long Outlet represent the smolt production of Long Lake, as the smolt trap was located near the lake. Smolts comprised 78% of the catch at Long Outlet and 72% at Misty Inlet. The mean sizes of coho smolts were 95 mm (SD=7.1, n=413) at Long Outlet and 100 mm (SD=10.1, n=224) at Misty Inlet. Coho parr were somewhat smaller, the means sizes being 94 mm (SD=13.1, n=139) and 92 mm (SD=8.4, n=105) at Long Outlet and Misty Inlet. Condition factors (w/l^3) for Long Outlet parr and smolts were 1.04(SD=0.16, n=54) and 1.02 (SD=0.09, n=210), while those for Misty Inlet were 1.04 (SD=0.08, n=61) and 1.03 (SD=0.13, n=165). These condition factors are considerably less than the 1.22 value reported for the same populations during the winter (Swales et al. 1988).

Both Dolly Varden and cutthroat trout were moderately abundant in the smolt trap catches. A total of 104 Dolly Varden and 104 cutthroat trout were caught at Misty Inlet, and 59 Dolly Varden and 60 cutthroat trout at Long Outlet. In contrast, only 11 rainbow trout were taken at Misty Inlet and 3 at Long Outlet.

Minnow trap catches between November 1985 and April 1987 at the six sampling sites are given in Appendix 4. Seven species of fish were caught - coho salmon, rainbow trout, cutthroat trout, Dolly Varden charr, three spined stickleback, and two sculpins, Cottus asper and C. aleuticus. Juvenile coho were common at all sites (Fig. 5 and 6), with CPUE's of 1-3 fish per trap-night. Coho were equally abundant in Misty Outlet, Misty Lake, and Misty Inlet, but were noticeably more abundant in Long Lake than in Long Outlet, and less abundant in the Keogh River. In general, seasonal changes in coho abundance were not evident, although the great variability in CPUE within samples may obscure seasonal changes. However, the June samples from the Keogh River had a high abundance of young of the year. Coho fry were captured in April in fine mesh minnow traps at Misty Outlet and the Keogh River, which suggests that spawning had occurred at these sites but not elsewhere.

Rainbow trout (probably steelhead) were most common in the Keogh River samples, and were rare in samples from Long Lake, Misty Lake, or Misty Inlet (Fig. 7 and 8). The catches at Misty Outlet showed an increase in November 1986, at the same time as the fry trap and counting fence catches, which confirms the movement of rainbow trout into the stream.

Dolly Varden charr were relatively common ($\geq$ 1 per trap-night) in Misty Inlet, Long Outlet, and Long Lake, but were scarce elsewhere (Fig. 9 and 10). Similarly, cutthroat

trout were most abundant (CPUE $\geq$ 0.5) in Misty Inlet, Long Outlet, and, to a lesser degree, Long Lake. Threespined stickleback were the most common fish in Misty Lake, with CPUE's of up to 22 fish per trap-night, although 2-3 per trap-night was more common. Stickleback were also common in Long Lake, though less abundant than in Misty Lake. Sculpins were not abundant at any sites.

Coho abundance estimated at Long Lake and Misty Lake using both mark-recapture estimators were in good agreement (Table 4). In all other cases, however, the Bayesian method did not converge to an estimate, which strongly suggests that the population was not closed, i.e., that there was considerable immigration/emigration within the trapping area during the 10 day period. As the traps were placed over a linear distance of about 150 m in both cases, the results suggest that the density of juvenile coho per m of shoreline in Long Lake was about 1.5 times that of Misty Lake.

Table 4. Mark-recapture estimates of coho abundance at minnow trapping sites, January and February 1987. M_t is the numbers of marked fish at large on day t, C_t is the number captured on day t, and R_t is the number of recaptures in C_t.

	Long Lake			Misty Lake		
Day	M_t	C_t	R_t	M_t	C_t	R_t
1	0	36	0	0	15	0
2	36	51	6	15	34	1
3	81	50	12	46	14	0
4	119	45	10	60	26	4
5	154	42	9	82	15	1
6	187	11	4	96	3	0
7	194	6	1	99	2	1
8	199	44	10	100	6	3
9	233	45	11	103	9	3
Schumacher estimate:			737			416
(95% CL)			(565 - 1060)			(266 - 951)
Bayesian estimate:			666			449
(95% CL)			(549 - 729)			(309 - 716)

Several important conclusions can be drawn from the present study. First, large numbers of juvenile coho seem to rear in small tributary streams and lakes throughout the summer and winter. Second, coho fry may actively migrate upstream soon after emergence to reach these small lakes and tributaries. Third, substantial numbers of coho smolts

emigrate from the small tributaries. Fourth, rainbow trout juveniles may immigrate in the fall to overwinter in small tributary streams.

The utilization of small tributaries and lakes as rearing habitat by young of the year coho suggests that more emphasis should be placed on the preservation and management of such habitats. Small lakes and shallow gradient tributary streams may not be considered important fish habitat in evaluating development proposals, such as logging plans, with the result that productive habitat may inadvertently be lost. Smolt production from Long Lake was about 1650 fish, while that of Misty Inlet stream was about 750. The total smolt production from the Misty drainage is likely to be similar to or greater than that of Long Lake. There are at least 19 distinct small tributaries to the Keogh River (Smith and Slaney 1980). If coho smolt production in the other tributaries is similar to that in Long Lake or Misty Inlet, then about 30,000 of the 65,000 coho smolts emigrating each year from the Keogh River may be produced in the small tributary lakes and streams. There is a clear need for a better understanding of the role of small tributary lakes and streams in the production of coho salmon.

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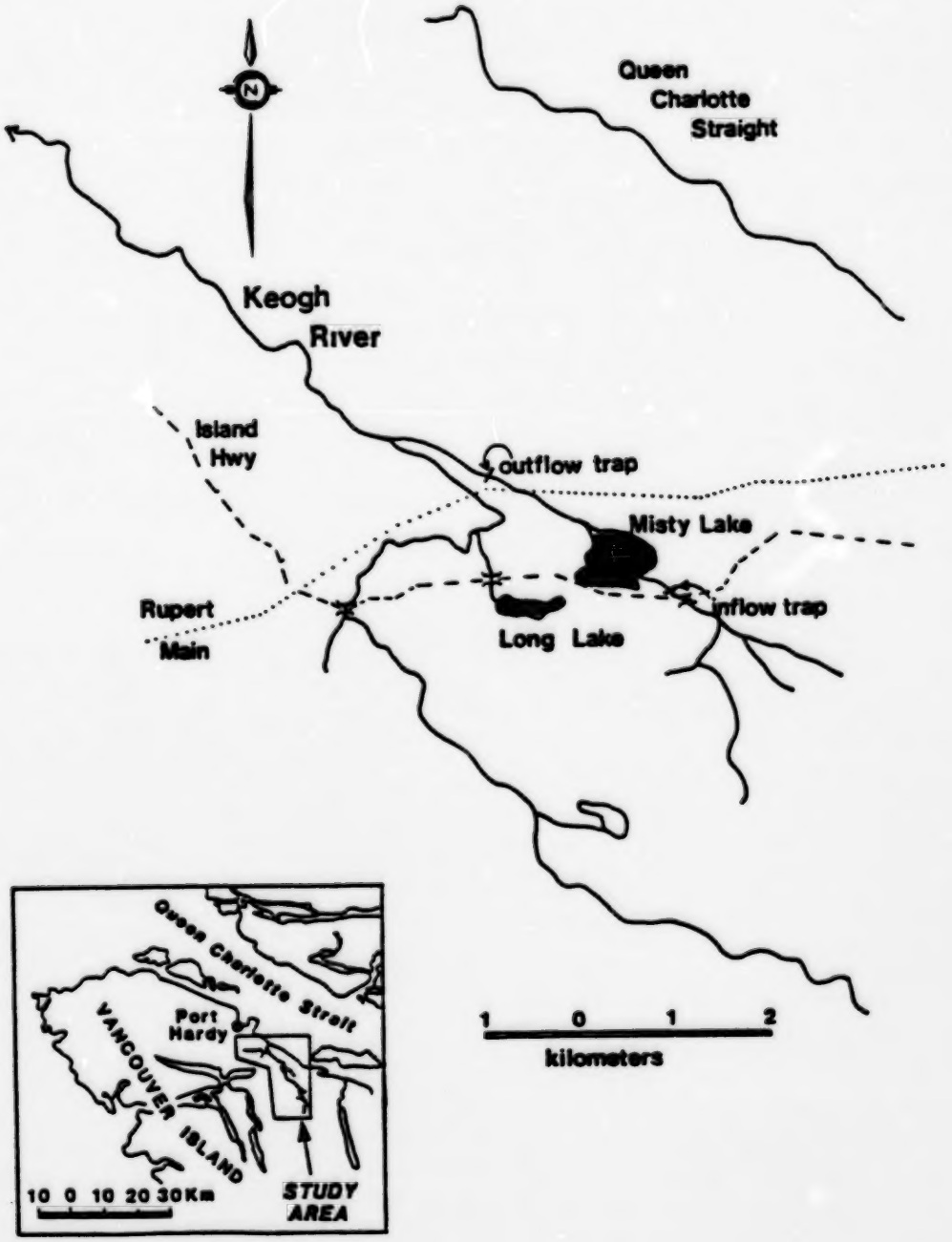

Fig. 1. A map of the study area showing the location of sampling sites and geographical features mentioned in the text

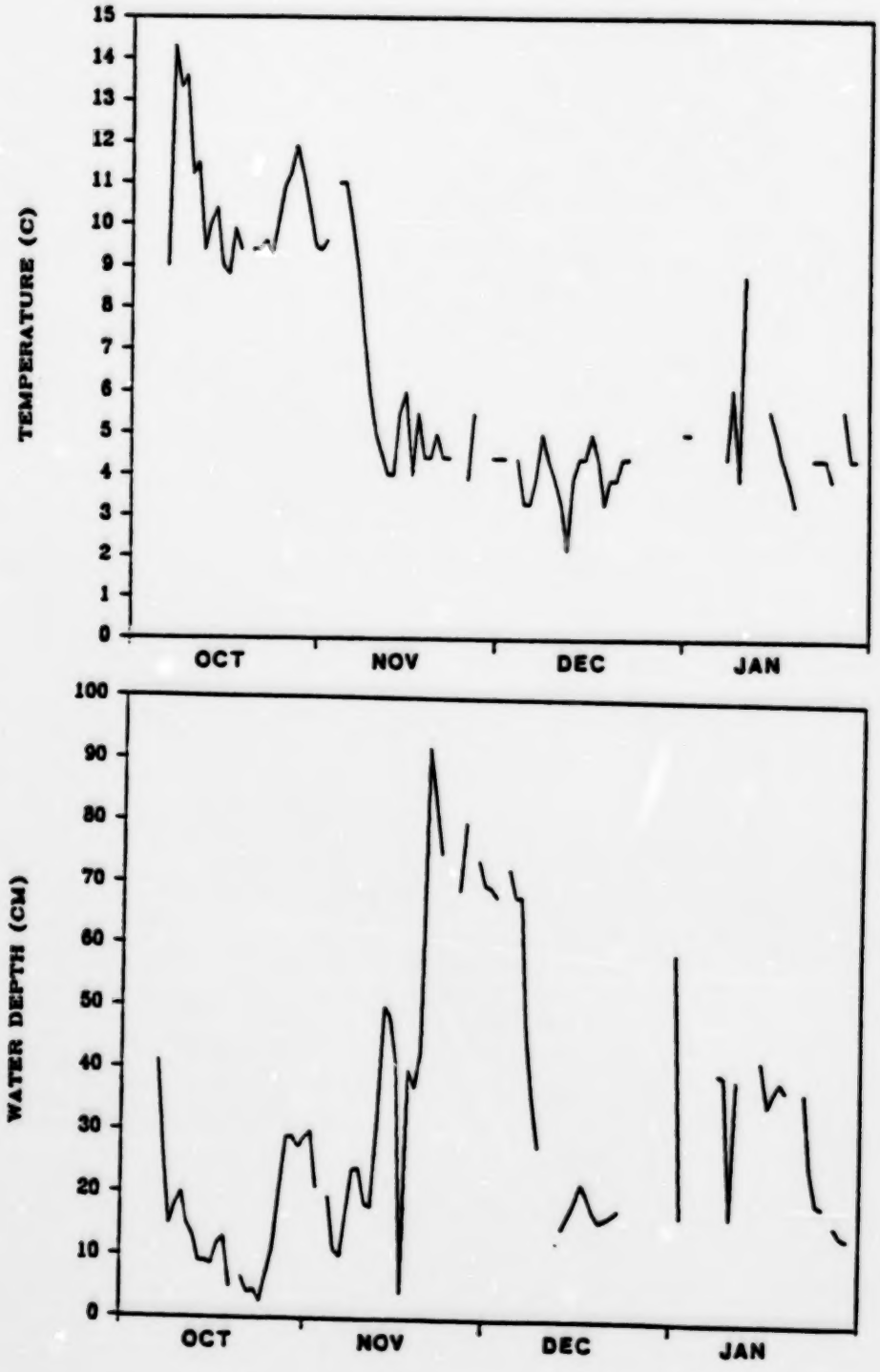

Fig. 2. Water temperature (upper) and water depth (lower) at the Misty Outlet stream counting fence, Oct. 1986 - Jan. 1987.

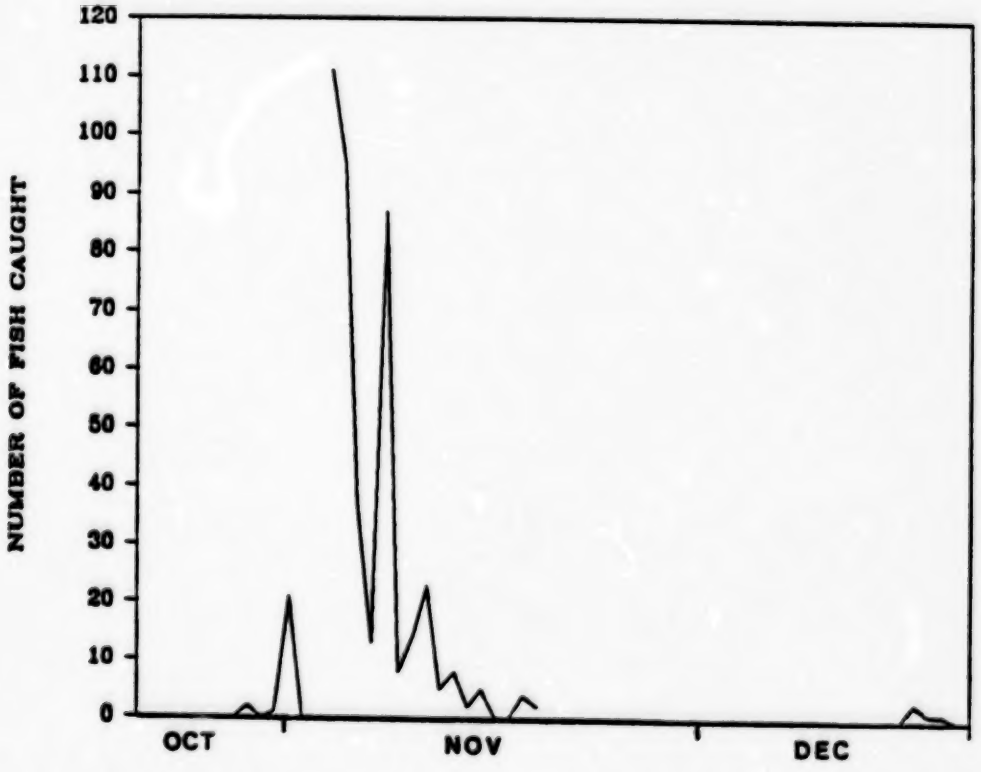

Fig. 3. Daily catches of rainbow trout at the Misty Outlet stream counting fence, fall 1986.

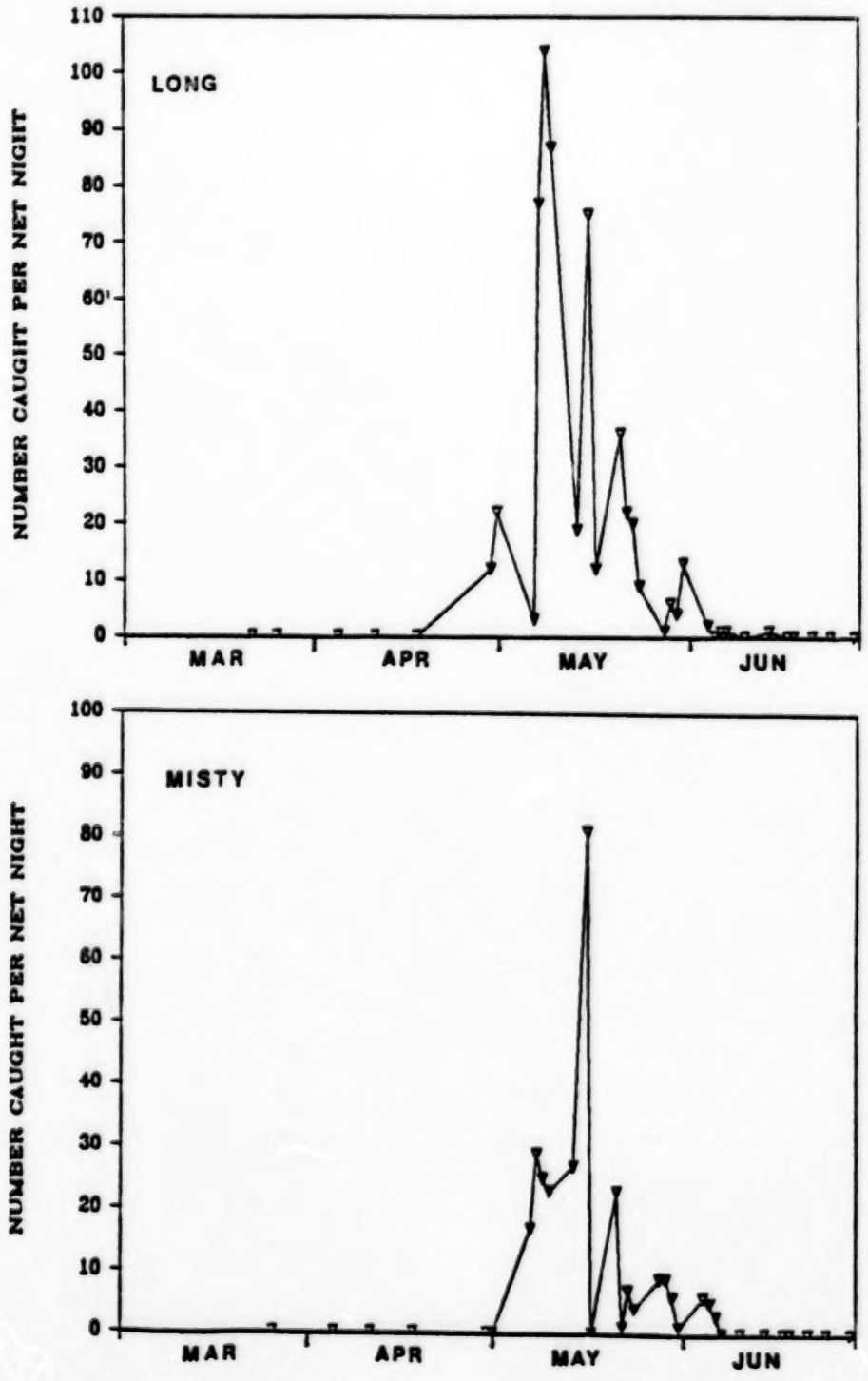

Fig. 4. Smolt trap catches of emigrating coho at Long Outlet and Misty Inlet streams, spring 1986.

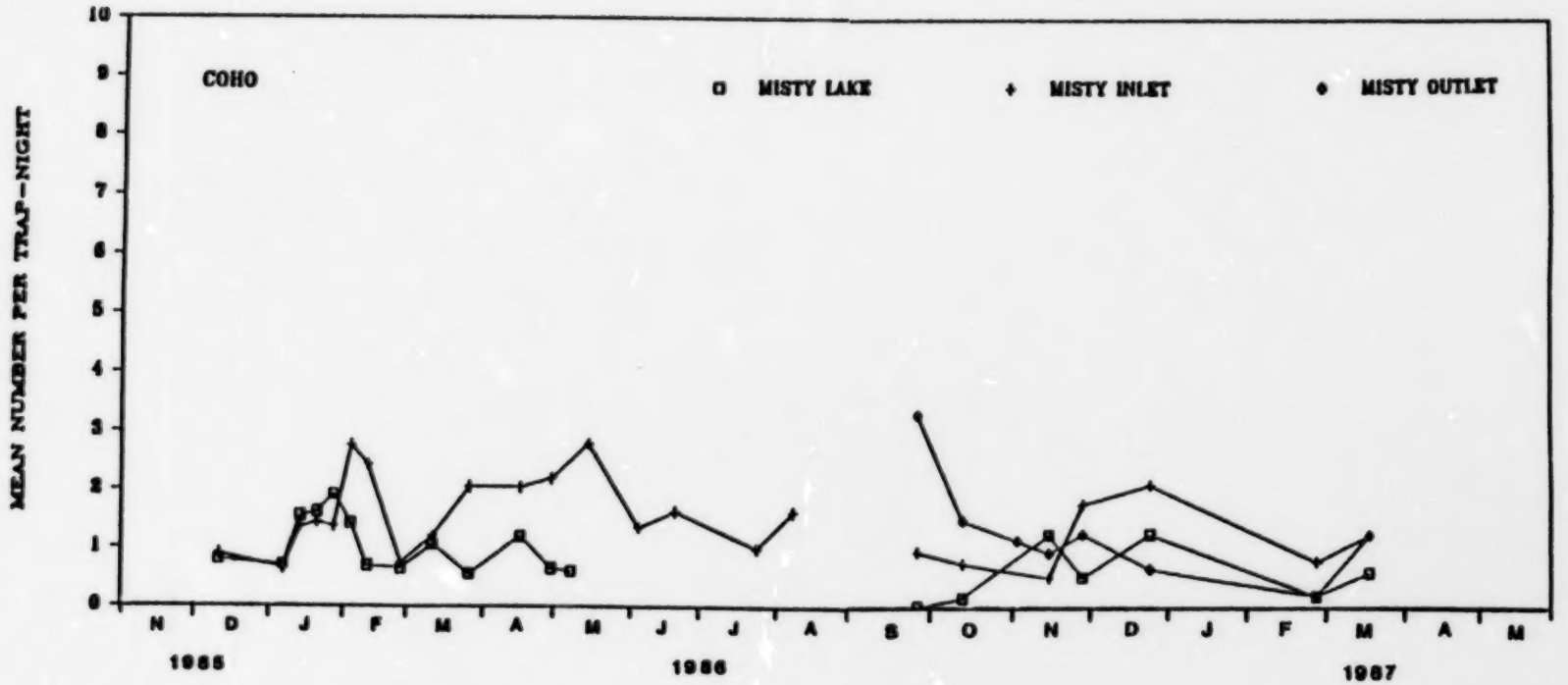

Fig. 5. Mean CPUE (fish per trap-night) of coho at the Misty drainage sampling sites, 1985-1987.

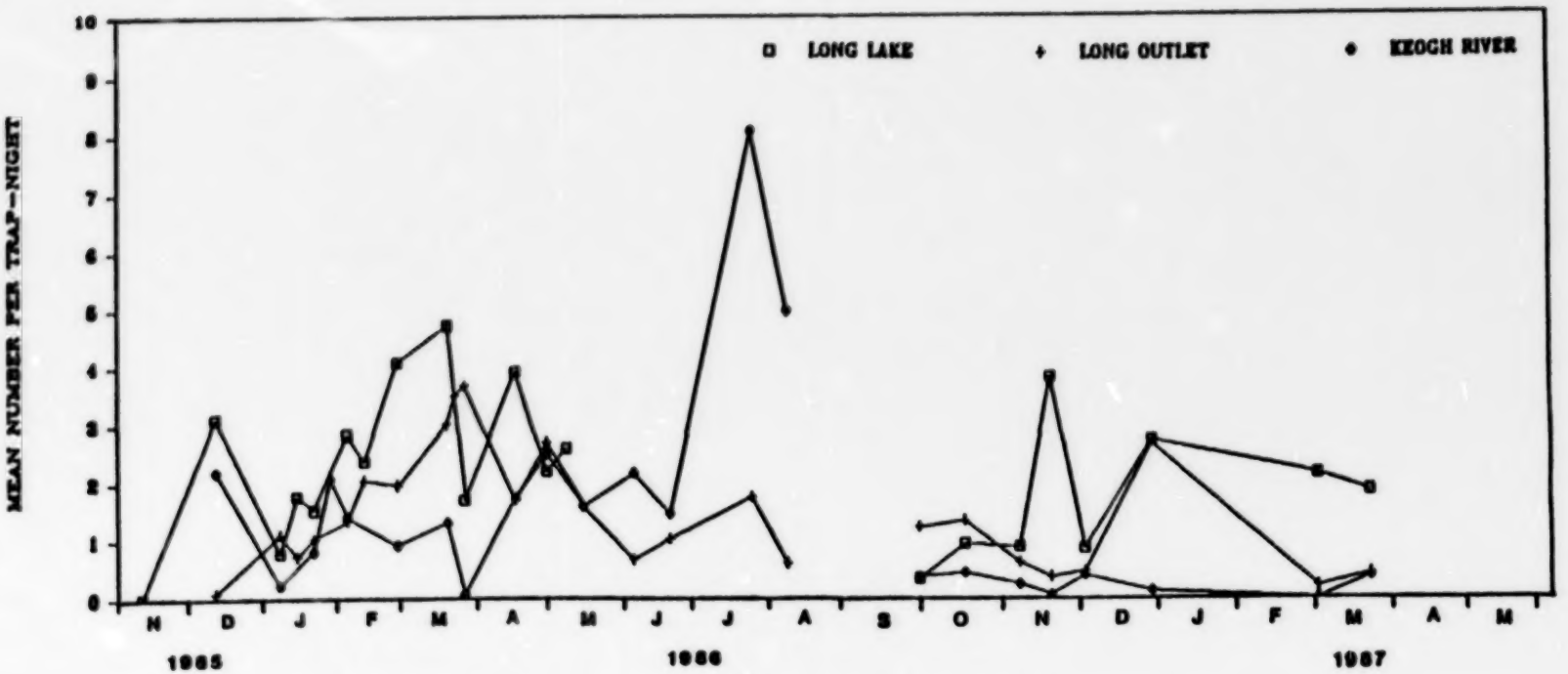

Fig. 6. Mean CPUE (fish per trap-night) of coho at the Long drainage sampling sites, 1985-1987.

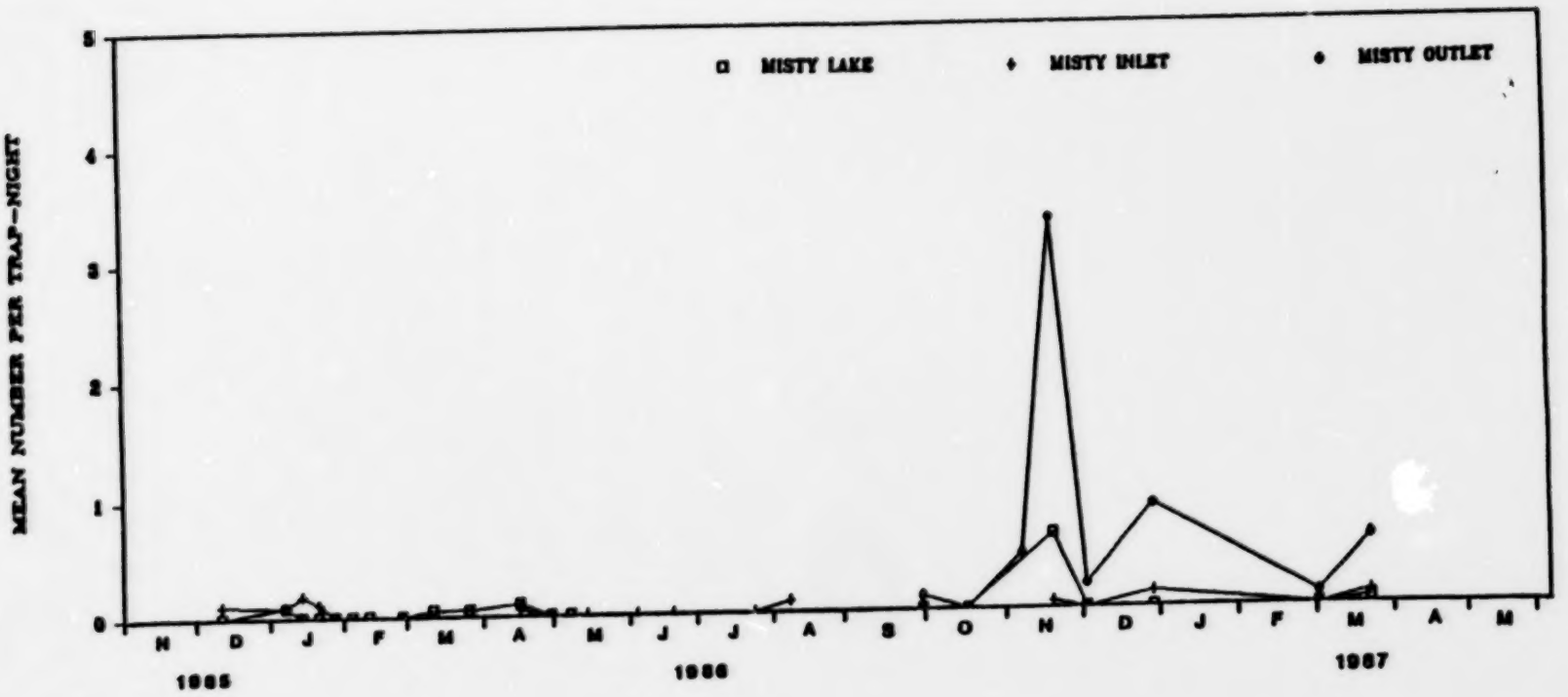

Fig. 7. Mean CPUE (fish per trap-night) of rainbow trout at the Misty drainage sampling sites, 1985-1987.

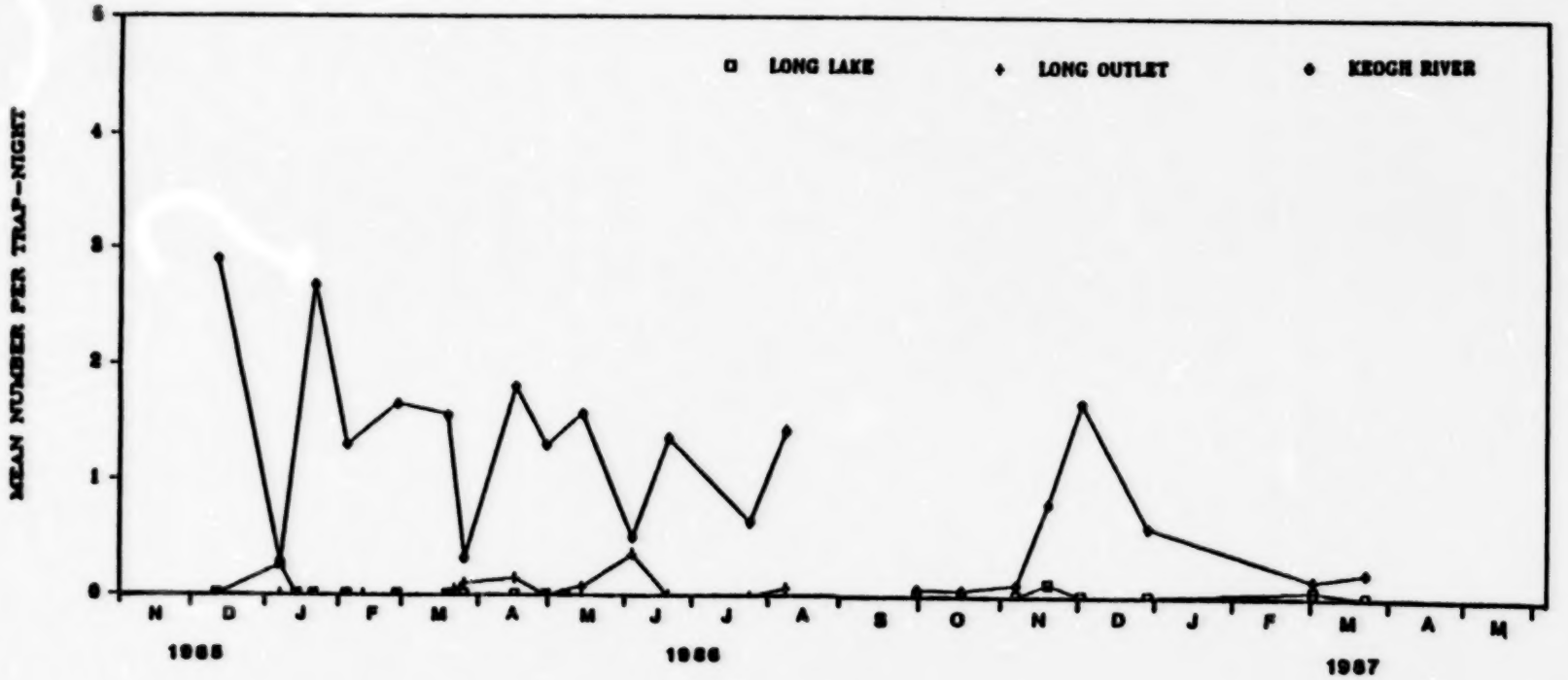

Fig. 8. Mean CPUE (fish per trap-night) of rainbow trout at the Long drainage sampling sites, 1985-1987.

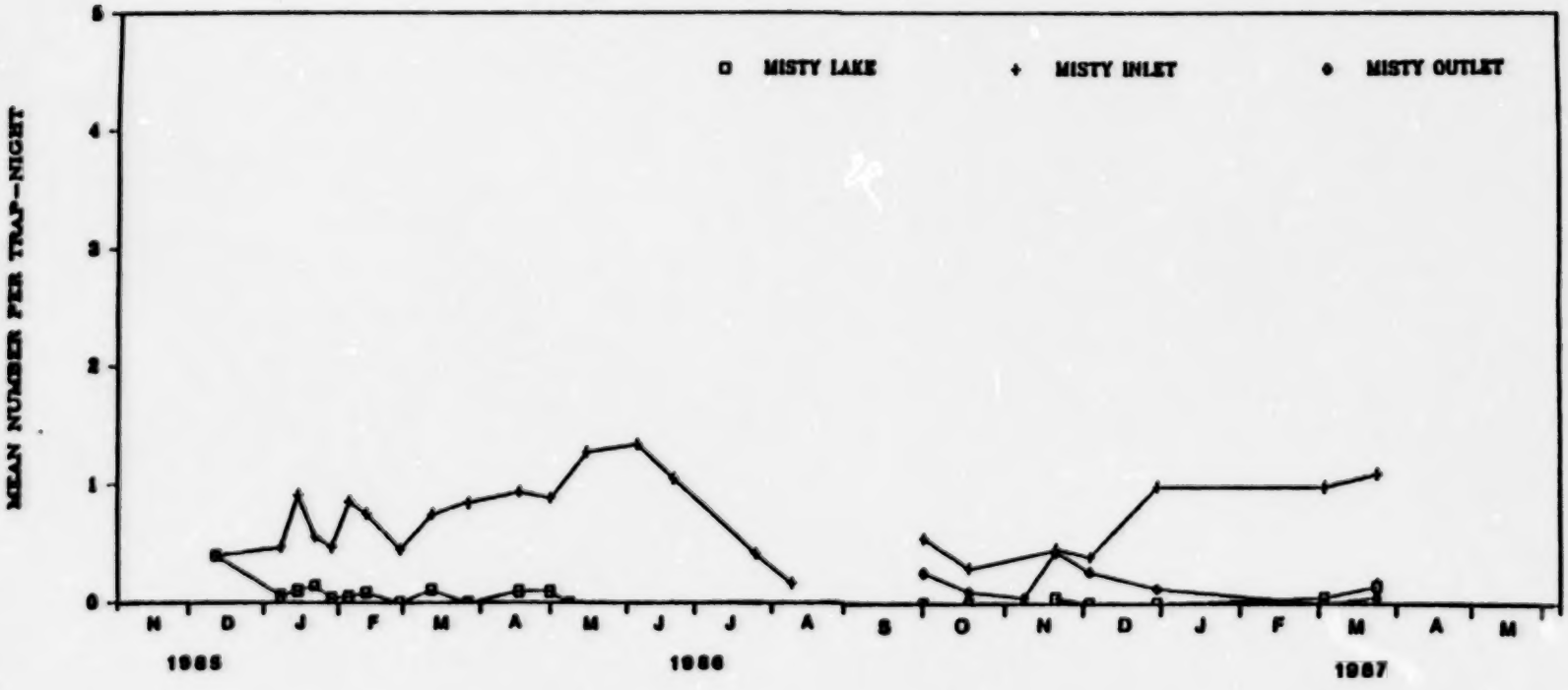

Fig. 9. Mean CPUE (fish per trap-night) of Dolly Varden at the Misty drainage sampling sites, 1985-1987.

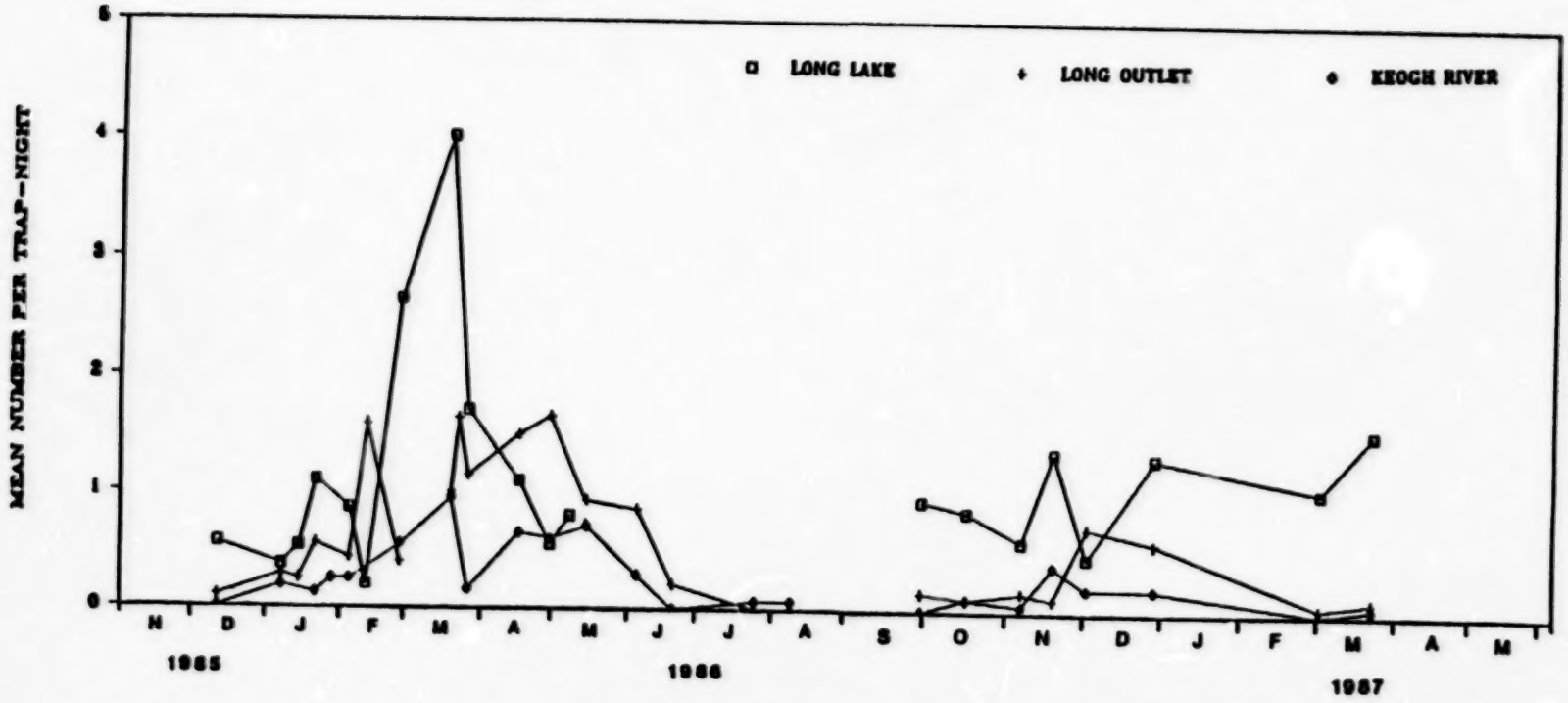

Fig. 10. Mean CPUE (fish per trap-night) of Dolly Varden at the Long drainage sampling sites, 1985-1987.

Appendix 1. Daily catch records for the Misty Outlet and Misty Inlet counting fences, October 1986 - January 1987

Date	Temp (°C)	Depth (cm)	Misty Outlet Coho	Rbt	Ctt	DV	Misty Inlet Coho	Rbt	Ctt	DV
06 Oct	9.0	41								
07	14.3	27								
08	13.3	15								
09	13.6	18								
10	11.2	20								
11	11.5	15								
12	9.4	13								
13	10.0	9								
14	10.4	9								
15	9.0	8								
16	9.8	12								
17	9.9	13								
18	9.4	5								
19	-	-								
20	9.4	7								
21	9.4	4								
22	9.6	5								
23	9.3	3								
24	10.1	7								
25	10.9	11								
26	11.2	20								
27	11.9	29								
28	11.2	29	3	2						
29	10.4	28								1
30	9.5	29	2	1						
31	9.4	30	4	21	1					
01 Nov	9.6	21								
02	-	-								
03	11.0	20	14	111						
04	11.0	11	10	95	1					
05	10.0	10	8	37						
06	9.0	17	7	13						
07	7.5	27	11	87	1	1				
08	6.0	24		8			1			
09	5.0	19		14			2	1		
10	4.5	18		23	1					
11	4.0	32		5						
12	4.0	50		8	9					
13	5.5	49		2						
14	6.0	41		5						
15	4.0	42								
16	5.5	40								
17	4.4	37		4		1				
18	4.4	43		2	1	2	fence not fishing			
19	5.0	92	fence not fishing				"	"	"	
20	4.4	84	"	"	"		"	"	"	
21	4.4	75					"	"	"	

(continued)

Appendix 1. (cont'd) Daily catch records for the Misty Outlet and Misty Inlet counting fences, October 1986 - January 1987.

Date	Temp (°C)	Depth (cm)	Misty Outlet Coho	Rbt	Ctt	DV	Misty Inlet Coho	Rbt	Ctt	DV
22 Nov	-	-					fence not fishing			
23	-	-					"	"	"	
24	3.9	69					"	"	"	
25	5.5	80					"	"	"	
26	-	-	fence not fishing				"	"	"	
27	-	74					"	"	"	
28	4.4	93					"	"	"	
29	4.4	70					"	"	"	
30	4.4	68					"	"	"	
01 Dec	-	-					"	"	"	
02	4.4	73					"	"	"	
03	3.3	68					"	"	"	
04	3.3	68					"	"	"	
05	3.9	46					"	"	"	
06	5.0	35					"	"	"	
07	4.4	28					"	"	"	
08	3.9	-								
09	3.3	19								
10	2.2	-								
11	3.9	15								
12	4.4	17			1					
13	4.4	19								
14	5.0	22								
15	4.4	20		3	1	1				
16	3.3	18		1	1					
17	3.9	16			1					
18	3.9	17								
19	4.4	17								
20	4.4	18								
21	-	-								
22	-	-								
23	-	-								
24	-	-								
25	-	-								
26	-	-								
27	-	-								
28	-	-								
29	5.0	59								
30	5.0	17								
31	-	-								
01 Jan	-	-								
02	-	-								
03	-	-								
04	-	-								
05	4.4	40								
06	6.1	40								
07	3.9	-								

(continued)

Appendix 1. (cont'd) Daily catch records for the Misty Outlet and Misty Inlet counting fences, October 1986 - January 1987.

Date	Temp (°C)	Depth (cm)	Misty Outlet Coho	Rbt	Ctt	DV	Misty Inlet Coho	Rbt	Ctt	DV
08 Jan	-	39								
09	-	-								
10	-	-								
11	-	-								
12	5.6	42								
13	5.0	35								
14	4.4	37								
15	3.9	39								
16	3.3	38								
17	-	-								
18	-	-								
19	4.4	37								
20	4.4	25	1	1						
21	4.4	20								
22	3.9	19								
23	-	-								
24	5.6	16		1						
25	4.4	15								
26	4.4	14								
TOTALS			60	445	17	5	3	2		2

Appendix 2. Daily catch records for upstream-downstream fry traps at Misty Outlet and Long Outlet, October 1986 - April 1987

Date	Misty Outlet								Long Outlet									
	upstream				downstream				upstream					downstream				
	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Sb	Co	Rb	Ct	DV	Sb
06 Oct																		
07																		
08					1													
09																		
10	1													1				1
11					1													
12																		
13																		
14																		
15																		
16																		
17																		1
18													1		1			1
19																		
20													1					
21													1					1
22																		
23													2					1
24													1					2
25					1													
26	1				1					1			2					
27													1					
28						1							1					
29						1												1
30		3																
31																		
01 Nov																		
02																		
03	5	14	1	1														2
04	1	15	3	2			1											
05		3	1		3	3												
06		2	1		1													
07																		1
08					4	6							2				1	
09	1	1																
10		1	1															
11																		
12																		
13	2			1											1		1	
14													1					
15																		
16																		
17																		
18																		
19																		

(continued)

Appendix 2. (cont'd) Daily catch records for upstream - downstream fry traps at Misty Outlet and Long Outlet, October 1986 - April 1987.

Date	Misty Outlet								Long Outlet							
	upstream				downstream				upstream					downstream				
	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Sb	Co	Rb	Ct	DV	Sb
20 Nov																		
21																		
22		no data...																
23		" "																
24																		
25	2																	
26																		
27																		
28																		
29																		
30	1																	3
01 Dec		no data																
02																		
03																		
04																		
05																		
06																		
07																		
08																		
09																		
10																		
11					1													
12						1												
13																		
14																		
15		1																2
16													1					
17																		
18																		
19																		
20																		
21		no data...																
29																		
30																		
31		no data...																
05 Jan																		
06																		
07																		
08																		
09		no data...																
12											1							1
13																		1
14																		
15																		
16																		

(continued)

Appendix 2. (cont'd) Daily catch records for upstream - downstream fry traps at Misty Outlet and Long Outlet, October 1986 - April 1987.

Date	Misty Outlet								Long Outlet									
	upstream				downstream				upstream					downstream				
	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Sb	Co	Rb	Ct	DV	Sb
17 Jan	no data																	
18	"	"																
19																		
20																		
21																		
22																		
23		2				1												
24	no data ...																	
04 Feb						1												
05	no data ...																	
11																		
12	no data ...																	
17						1												
18	no data ...																	
18 Mar 1	3																	
19	1	1																
20		1																
21																		
22																		
23	1				1													
24																		
25	no data ...																	
30	2	2		1		1												
31	no data																	
01 Apr 2													1					
02	no data ...																	
07	1	1			1													1
08	no data ...																	
13																		
TOTAL	22	50	7	5	15	16	1	0	02	0	0	0	15	1	2	0	2	19

Species codes: Co = Coho
Rb = Rainbow trout
Ct = Cutthroat trout
DV = Dolly Varden charr
Sb = Three-spined stickleback

(continued)

Appendix 2. (cont'd) Daily catch records for upstream - downstream fry traps at Misty Inlet, October 1986 - April 1987.

Date	upstream					downstream				
	Co	Rb	Ct	DV	Sb	Co	Rb	Ct	DV	Sb
23 Oct 1986						1				
08 Nov						1				
10					1					
23 Jan 1987						1				
19 Mar	1	2		2	1					
20		1								
21							1			
23						1				
30			1							
07 Apr										1
13			2							
TOTAL	1	3	3	2	2	4	1	0	0	1

Appendix 3. Daily catch records for small, nearshore upstream-downstream fry traps at Misty Outlet and Misty Inlet, spring 1987.

Date	Misty Outlet								Misty Inlet									
	upstream				downstream				upstream					downstream				
	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Co	Rb	Ct	DV	Sb	Co	Rb	Ct	DV	Sb
18 Mar																		
19																		
20		2																
23													1					2
24															2			1
30	1														1			
01 Ap	10				1	1									1			
06	44	2			3	2									1			
13	no	data													1			
TOTAL	55	4	0	0	4	3	0	0	0	0	0	0	1	0	6	0	0	3

Appendix 4. Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987. n is the number of traps.

MISTY LAKE:

11 Dec 1985	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.80	0.40	0.00	0.00	7.50
Variance	2.18	0.71	0.00	0.00	45.61
n	10	10	10	10	10

06 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.33	0.00	0.17	0.00	0.00
Variance	1.06	0.00	0.26	0.00	0.00
n	18	18	18	18	18

16 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.55	0.10	0.00	0.00	10.45
Variance	3.21	0.09	0.00	0.00	156.79
n	20	20	20	20	20

21 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.62	0.14	0.00	0.00	1.72
Variance	4.74	0.12	0.00	0.00	5.42
n	29	29	29	29	29

28 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.92	0.04	0.00	0.00	5.48
Variance	5.83	0.04	0.00	0.00	19.68
n	25	25	25	25	25

04 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.43	0.05	0.00	0.00	1.71
Variance	5.26	0.05	0.00	0.00	3.51
n	21	21	21	21	21

14 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.69	0.08	0.00	0.00	2.33
Variance	1.75	0.12	0.00	0.00	10.98
n	36	36	36	36	36

25 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.65	0.00	0.00	0.00	1.30
Variance	0.56	0.00	0.00	0.00	1.80
n	20	20	20	20	20

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

MISTY LAKE

11 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.05	0.11	0.05	0.00	1.37
Variance	0.83	0.10	0.05	0.00	1.25
n	19	19	19	19	19

25 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.55	0.00	0.05	0.05	4.55
Variance	0.47	0.00	0.05	0.05	26.16
n	20	20	20	20	20

15 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.20	0.10	0.10	0.00	3.90
Variance	2.27	0.20	0.09	0.00	23.78
n	20	20	20	20	20

30 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.65	0.10	0.00	0.00	22.80
Variance	0.56	0.09	0.00	0.00	185.54
n	20	20	20	20	20

07 May 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.60	0.00	0.00	0.10	21.45
Variance	0.88	0.00	0.00	0.20	111.00
n	20	20	20	20	20

03 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.00	0.00	0.00	0.00	3.30
Variance	0.00	0.00	0.00	0.00	19.59
n	20	20	20	20	20

21 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.15	0.00	0.00	0.00	1.85
Variance	0.13	0.00	0.00	0.00	6.56
n	20	20	20	20	20

26 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.26	0.05	0.63	0.00	2.53
Variance	2.76	0.05	1.13	0.00	8.04
n	19	19	19	19	19

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

MISTY LAKE

12 Dec 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.53	0.00	0.00	0.00	0.73
Variance	0.55	0.00	0.00	0.00	1.50
n	15	15	15	15	15

07 Jan 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.27	0.00	0.00	0.00	0.07
Variance	1.35	0.00	0.00	0.00	0.07
n	15	15	15	15	15

18 Mar 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.20	0.05	0.00	0.05	6.15
Variance	0.17	0.05	0.00	0.05	137.82
n	20	20	20	20	20

10 Apr 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.60	0.15	0.05	0.00	1.85
Variance	1.09	0.13	0.05	0.00	14.24
n	20	20	20	20	20

MISTY INLET STREAM

11 Dec 1985	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.90	0.40	0.10	0.50	0.00
Variance	2.99	0.49	0.10	0.72	0.00
n	10	10	10	10	10

07 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.65	0.47	0.18	0.29	0.00
Variance	0.99	0.76	0.15	0.72	0.00
n	17	17	17	17	17

14 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.36	0.91	0.18	0.27	0.00
Variance	5.65	1.49	0.16	0.22	0.00
n	11	11	11	11	11

21 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.44	0.56	0.11	0.22	0.00
Variance	2.14	0.50	0.22	0.30	0.00
n	18	18	18	18	18

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

MISTY INLET STREAM

28 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.37	0.47	0.00	0.21	0.05
Variance	3.47	0.49	0.00	0.18	0.05
n	19	19	19	19	19

04 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.76	0.86	0.00	0.14	0.24
Variance	5.19	1.53	0.00	0.13	0.39
n	21	21	21	21	21

14 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.42	0.75	0.00	0.42	0.00
Variance	2.99	1.48	0.00	0.27	0.00
n	12	12	12	12	12

25 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.75	0.45	0.00	0.20	0.05
Variance	0.72	0.47	0.00	0.17	0.05
n	20	20	20	20	20

11 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.20	0.75	0.00	0.60	0.30
Variance	1.85	2.51	0.00	0.78	0.43
n	20	20	20	20	20

25 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.05	0.85	0.00	0.55	0.60
Variance	3.31	1.71	0.00	0.47	2.25
n	20	20	20	20	20

15 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.05	0.95	0.05	0.50	0.35
Variance	3.21	1.42	0.05	0.47	0.87
n	20	20	20	20	20

29 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.20	0.90	0.00	0.25	0.20
Variance	4.27	1.57	0.00	0.20	0.48
n	20	20	20	20	20

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

MISTY INLET STREAM

13 May 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.79	1.29	0.00	0.57	0.29
Variance	2.80	2.37	0.00	0.73	1.14
n	14	14	14	14	14

03 Jun 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.36	1.36	0.00	0.86	0.14
Variance	1.79	2.25	0.00	0.90	0.13
n	14	14	14	14	14

18 Jun 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.64	1.07	0.00	0.71	1.00
Variance	2.09	4.53	0.00	0.99	4.92
n	14	14	14	14	14

22 Jul 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.00	0.43	0.00	0.36	0.21
Variance	1.08	0.42	0.00	0.40	0.34
n	14	14	14	14	14

06 Aug 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.64	0.18	0.09	0.18	0.82
Variance	3.85	0.16	0.09	0.36	2.16
n	11	11	11	11	11

03 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.95	0.55	0.00	0.10	0.90
Variance	2.68	0.79	0.00	0.09	4.73
n	20	20	20	20	20

21 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.75	0.30	0.00	0.25	0.10
Variance	1.25	0.33	0.00	0.20	0.09
n	20	20	20	20	20

27 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.53	0.47	0.05	0.05	5.00
Variance	1.26	0.93	0.05	0.05	475.00
n	19	19	19	19	19

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

MISTY INLET STREAM

12 Dec 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.80	0.40	0.00	0.20	0.20
Variance	5.03	0.40	0.00	0.17	0.31
n	15	15	15	15	15

08 Jan 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.13	1.00	0.13	0.00	0.20
Variance	2.70	2.57	0.12	0.17	0.60
n	15	15	15	15	15

19 Mar 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.80	1.00	0.00	0.25	0.10
Variance	1.01	1.05	0.00	0.20	0.09
n	20	20	20	20	20

08 Apr 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.26	1.11	0.11	0.26	0.68
Variance	2.32	3.21	0.10	0.54	1.01
n	19	19	19	19	19

MISTY OUTLET STREAM

04 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.32	0.26	0.11	0.16	1.84
Variance	6.23	0.32	0.10	0.25	13.92
n	19	19	19	19	19

23 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.50	0.10	0.00	0.00	1.10
Variance	3.53	0.09	0.00	0.00	11.46
n	20	20	20	20	20

14 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.16	0.05	0.47	0.00	0.16
Variance	9.58	0.05	0.71	0.00	0.25
n	19	19	19	19	19

28 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.94	0.44	3.31	0.00	0.31
Variance	1.80	0.66	6.76	0.00	1.56
n	16	16	16	16	16

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

MISTY OUTLET STREAM

09 Dec 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.27	0.27	0.20	0.00	0.07
Variance	2.35	0.21	0.31	0.00	0.07
n	15	15	15	15	15

06 Jan 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.67	0.13	0.87	0.00	0.07
Variance	4.38	0.27	2.27	0.00	0.07
n	15	15	15	15	15

17 Mar 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.20	0.00	0.10	0.10	0.00
Variance	0.17	0.00	0.09	0.09	0.00
n	20	20	20	20	20

10 Apr 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.26	0.05	0.58	0.00	0.89
Variance	4.32	0.05	1.04	0.00	3.65
n	19	19	19	19	19

LONG LAKE

11 Dec 1985	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.11	0.56	0.00	0.00	0.22
Variance	3.36	0.53	0.00	0.00	0.19
n	9	9	9	9	9

10 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.80	0.37	0.26	0.03	0.06
Variance	0.00	0.00	0.00	0.00	0.00
n	35	35	35	35	35

17 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.79	0.53	0.00	0.04	0.04
Variance	0.00	0.00	0.00	0.00	0.00
n	47	47	47	47	47

22 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.55	1.10	0.00	0.15	0.00
Variance	1.21	1.25	0.00	0.13	0.00
n	20	20	20	20	20

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

LONG LAKE

05 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.86	0.86	0.00	0.10	0.14
Variance	4.73	2.13	0.00	0.09	0.13
n	21	21	21	21	21

12 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.40	0.20	0.00	0.00	0.27
Variance	7.69	0.17	0.00	0.00	0.35
n	15	15	15	15	15

26 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	4.10	2.65	0.00	0.00	0.00
Variance	5.88	4.03	0.00	0.00	0.00
n	20	20	20	20	20

18 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	4.75	4.00	0.00	0.00	1.20
Variance	13.36	17.58	0.00	0.00	3.64
n	20	20	20	20	20

26 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.75	1.70	0.00	0.10	0.20
Variance	2.83	2.96	0.00	0.20	0.17
n	20	20	20	20	20

16 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.95	1.10	0.00	0.05	1.10
Variance	8.58	1.88	0.00	0.05	3.88
n	20	20	20	20	20

30 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.25	0.55	0.00	0.25	1.80
Variance	3.36	0.37	0.00	0.30	4.69
n	20	20	20	20	20

02 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.35	0.94	0.00	0.06	0.29
Variance	0.24	1.18	0.00	0.06	0.35
n	17	17	17	17	17

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

LONG LAKE

22 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.95	0.85	0.00	0.00	0.10
Variance	1.63	1.92	0.00	0.00	0.09
n	20	20	20	20	20

13 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.90	0.60	0.00	0.00	0.15
Variance	1.25	0.67	0.00	0.00	0.24
n	20	20	20	20	20

26 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.79	1.37	0.11	0.11	0.11
Variance	3.40	1.58	0.10	0.10	0.21
n	19	19	19	19	19

11 Dec 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.87	0.47	0.00	0.00	0.07
Variance	2.84	0.70	0.00	0.00	0.07
n	15	15	15	15	15

07 Jan 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.73	1.33	0.00	0.00	0.00
Variance	4.21	0.95	0.00	0.00	0.00
n	15	15	15	15	15

18 Mar 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.15	1.05	0.05	0.00	0.35
Variance	2.98	0.89	0.05	0.00	0.34
n	20	20	20	20	20

09 Apr 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.85	1.55	0.00	0.20	0.20
Variance	2.34	2.79	0.00	0.27	0.17
n	20	20	20	20	20

LONG OUTLET STREAM

11 Dec 1985	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.10	0.10	0.00	0.40	0.00
Variance	0.10	0.10	0.00	0.49	0.00
n	10	10	10	10	10

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

LONG OUTLET STREAM

08 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.12	0.29	0.00	0.12	0.47
Variance	1.49	0.60	0.00	0.24	1.14
n	17	17	17	17	17

14 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.75	0.25	0.00	0.25	0.08
Variance	1.30	0.39	0.00	0.39	0.08
n	12	12	12	12	12

22 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.05	0.55	0.00	0.05	0.10
Variance	2.37	1.42	0.00	0.05	0.09
n	20	20	20	20	20

05 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.38	0.43	0.00	0.05	0.14
Variance	2.25	0.96	0.00	0,05	0.23
n	21	21	21	21	21

12 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.08	1.58	0.00	0.00	0.33
Variance	8.08	2.45	0.00	0.00	0.61
n	12	12	12	12	12

26 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.00	0.40	0.00	0.10	0.20
Variance	19.47	0.36	0.00	0.20	0.80
n	20	20	20	20	20

18 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.05	1.00	0.00	0.35	0.10
Variance	8.05	1.37	0.00	0.24	0.09
n	20	20	20	20	20

21 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.53	1.63	0.05	0.26	0.21
Variance	17.26	3.02	0.05	0.87	0.29
n	19	19	19	19	19

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

LONG OUTLET STREAM

26 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	3.70	1.15	0.10	0.10	0.20
Variance	6.01	2.87	0.09	0.09	0.48
n	20	20	20	20	20

16 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.75	1.50	0.15	0.10	1.20
Variance	6.62	3.95	0.24	0.09	16.27
n	20	20	20	20	20

30 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.75	1.65	0.00	0.40	0.25
Variance	6.72	2.77	0.00	0.67	0.83
n	20	20	20	20	20

13 May 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.64	0.93	0.07	0.36	0.86
Variance	4.86	2.07	0.07	0.55	1.52
n	14	14	14	14	14

03 Jun 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.71	0.86	0.36	0.36	0.43
Variance	1.76	1.98	0.55	0.55	0.57
n	14	14	14	14	14

18 Jun 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.07	0.21	0.00	0.50	0.57
Variance	0.99	0.34	0.00	0.42	0.57
n	14	14	14	14	14

22 Jul 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.79	0.00	0.00	0.00	1.57
Variance	3.41	0.00	0.00	0.00	5.49
n	14	14	14	14	14

06 Aug 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.64	0.00	0.07	0.07	1.21
Variance	0.71	0.00	0.07	0.07	2.34
n	14	14	14	14	14

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

LONG OUTLET STREAM

02 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.25	0.15	0.00	0.45	1.35
Variance	3.25	0.13	0.00	0.58	4.24
n	20	20	20	20	20

22 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.35	0.10	0.15	0.05	0.00
Variance	1.82	0.09	0.24	0.05	0.00
n	20	20	20	20	20

13 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.63	0.16	0.68	0.05	0.00
Variance	1.02	0.14	1.45	0.05	0.00
n	19	19	19	19	19

27 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.37	0.11	0.47	0.00	0.00
Variance	0.69	0.10	0.82	0.00	0.00
n	19	19	19	19	19

11 Dec 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.47	0.73	0.07	0.00	0.00
Variance	1.12	1.07	0.07	0.00	0.00
n	15	15	15	15	15

07 Jan 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.67	0.60	0.47	0.00	0.00
Variance	23.10	1.40	1.70	0.00	0.00
n	15	15	15	15	15

19 Mar 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.20	0.05	0.05	0.00	0.15
Variance	0.27	0.05	0.05	0.00	0.24
n	20	20	20	20	20

09 Apr 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.42	0.11	0.16	0.00	0.42
Variance	0.37	0.10	0.14	0.00	0.70
n	19	19	19	19	19

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

KEOGH RIVER

11 Dec 1985	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.20	0.00	2.90	0.00	0.00
Variance	9.96	0.00	12.77	0.00	0.00
n	10	10	10	10	10

08 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.24	0.19	0.29	0.10	0.05
Variance	0.39	0.26	0.31	0.09	0.05
n	21	21	21	21	21

23 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.83	0.13	2.67	0.00	0.00
Variance	1.59	0.19	7.06	0.00	0.00
n	30	30	30	30	30

29 Jan 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.10	0.25	2.40	0.05	0.00
Variance	17.25	0.51	9.09	0.05	0.00
n	20	20	20	20	20

06 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.45	0.25	1.30	0.00	0.00
Variance	7.31	0.30	1.69	0.00	0.00
n	20	20	20	20	20

27 Feb 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.95	0.55	1.65	0.05	0.00
Variance	2.37	0.58	3.61	0.05	0.00
n	20	20	20	20	20

18 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.35	0.95	1.55	0.05	0.00
Variance	6.24	1.21	2.26	0.05	0.00
n	20	20	20	20	20

26 Mar 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.11	0.16	0.32	0.00	0.00
Variance	0.10	0.14	0.34	0.00	0.00
n	19	19	19	19	19

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

KEOGH RIVER

17 Apr 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.80	0.65	1.80	0.00	0.00
Variance	7.54	1.19	6.06	0.00	0.00
n	20	20	20	20	20

01 May 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.55	0.60	1.30	0.00	0.00
Variance	15.21	0.46	3.59	0.00	0.00
n	20	20	20	20	20

14 May 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.64	0.71	1.57	0.00	0.00
Variance	6.71	0.37	1.96	0.00	0.00
n	14	14	14	14	14

03 Jun 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	2.21	0.29	0.50	0.00	0.36
Variance	3.57	0.22	0.73	0.00	0.71
n	14	14	14	14	14

20 Jun 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	1.50	0.00	1.36	0.00	0.00
Variance	2.88	0.00	5.32	0.00	0.00
n	14	14	14	14	14

23 Jul 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	8.07	0.07	0.64	0.00	0.07
Variance	43.76	0.07	1.79	0.00	0.07
n	14	14	14	14	14

07 Aug 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	5.00	0.07	1.43	0.00	0.00
Variance	19.38	0.07	3.49	0.00	0.00
n	14	14	14	14	14

04 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.39	0.00	0.06	0.00	0.11
Variance	1.43	0.00	0.06	0.00	0.22
n	18	18	18	18	18

Appendix 4. (cont'd) Mean CPUE (fish per trap-night) at minnow trapping sites in the Keogh River drainage, 1985-1987.

KEOGH RIVER

23 Oct 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.45	0.10	0.05	0.00	1.40
Variance	0.68	0.09	0.05	0.00	33.62
n	20	20	20	20	20

14 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.25	0.05	0.10	0.00	0.25
Variance	0.41	0.05	0.09	0.00	0.30
n	20	20	20	20	20

27 Nov 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.07	0.40	0.80	0.00	0.00
Variance	0.07	0.54	1.89	0.00	0.00
n	15	15	15	15	15

10 Dec 1986	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.40	0.20	1.67	0.00	0.00
Variance	1.11	0.31	6.67	0.00	0.00
n	15	15	15	15	15

06 Jan 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.13	0.20	0.60	0.00	0.13
Variance	0.12	0.17	1.40	0.00	0.12
n	15	15	15	15	15

17 Mar 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.00	0.00	0.15	0.00	0.00
Variance	0.00	0.00	0.13	0.00	0.00
n	20	20	20	20	20

08 Apr 1987	Coho	Dolly Varden	Rainbow Trout	Cutthroat Trout	Threespined Stickleback
Mean CPUE	0.37	0.05	0.21	0.00	0.00
Variance	0.69	0.05	0.51	0.00	0.00
n	19	19	19	19	19